Jan. 2, 1923.

1,440,857

G. D. WHITE.

PRODUCER FURNACE.

FILED MAR. 15, 1920.

6 SHEETS-SHEET 1

Fig. 1.

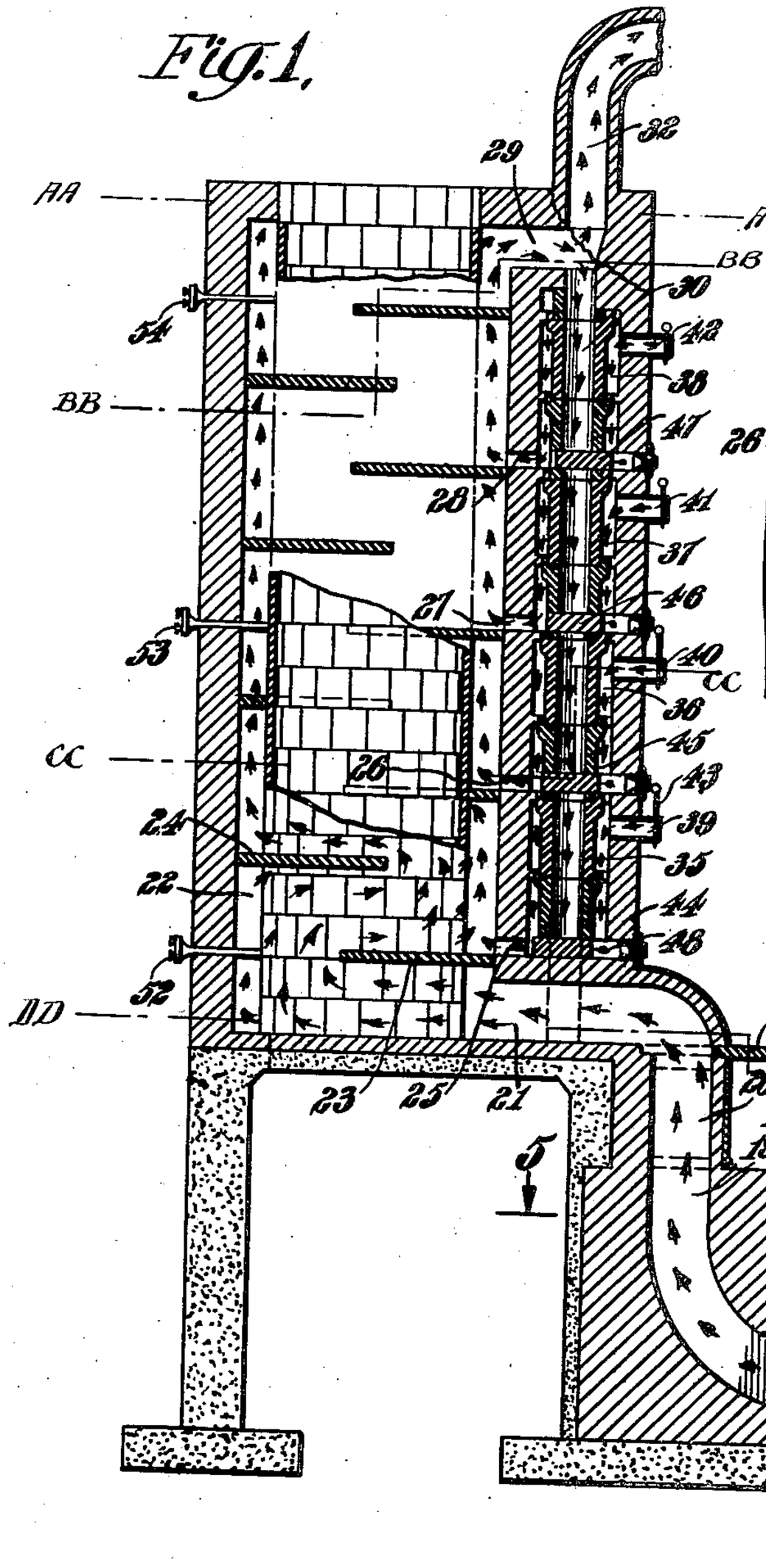
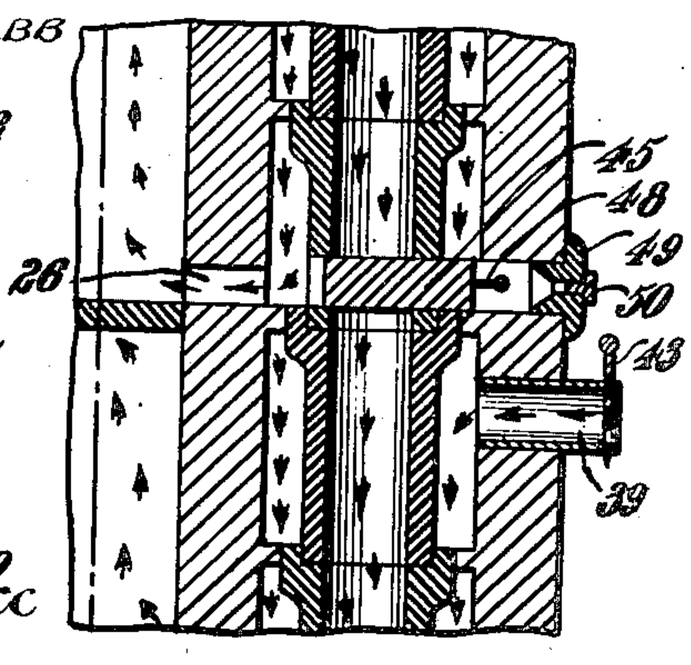



Fig. 2.

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6 SHEETS-SHEET 2

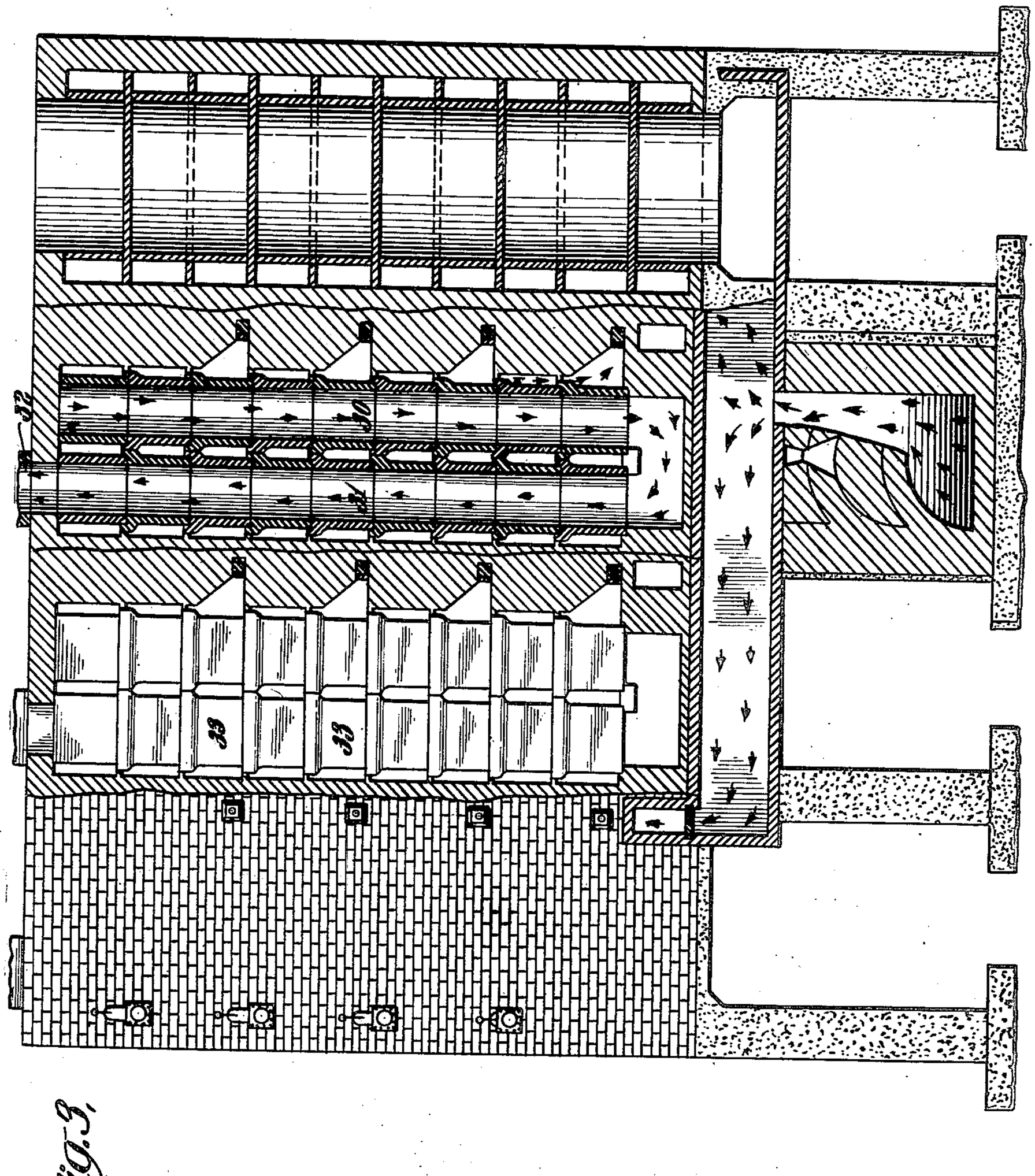


Fig. 3.

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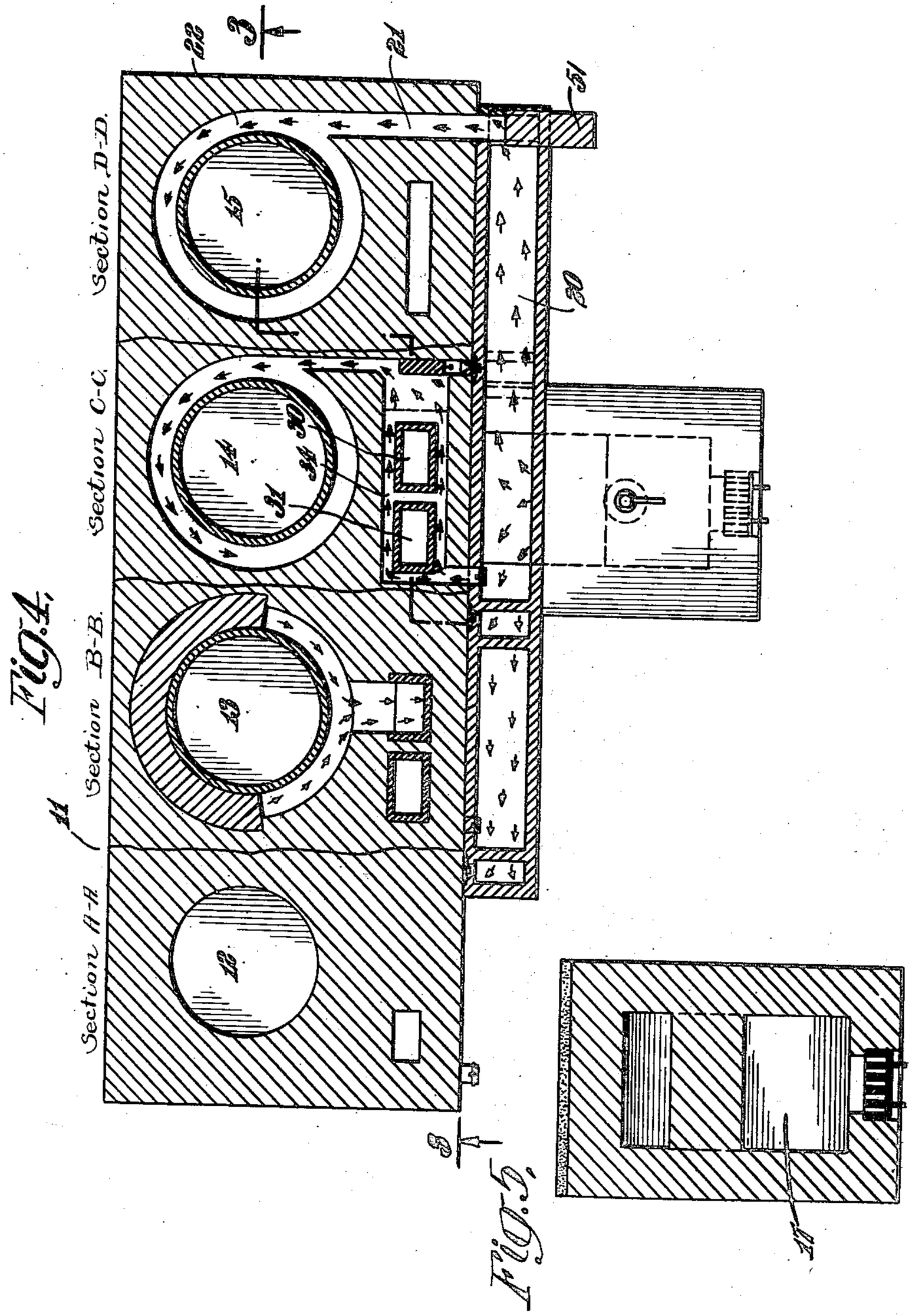
FILED MAR. 15, 1920.

1,440,857

6 SHEETS-SHEET 3

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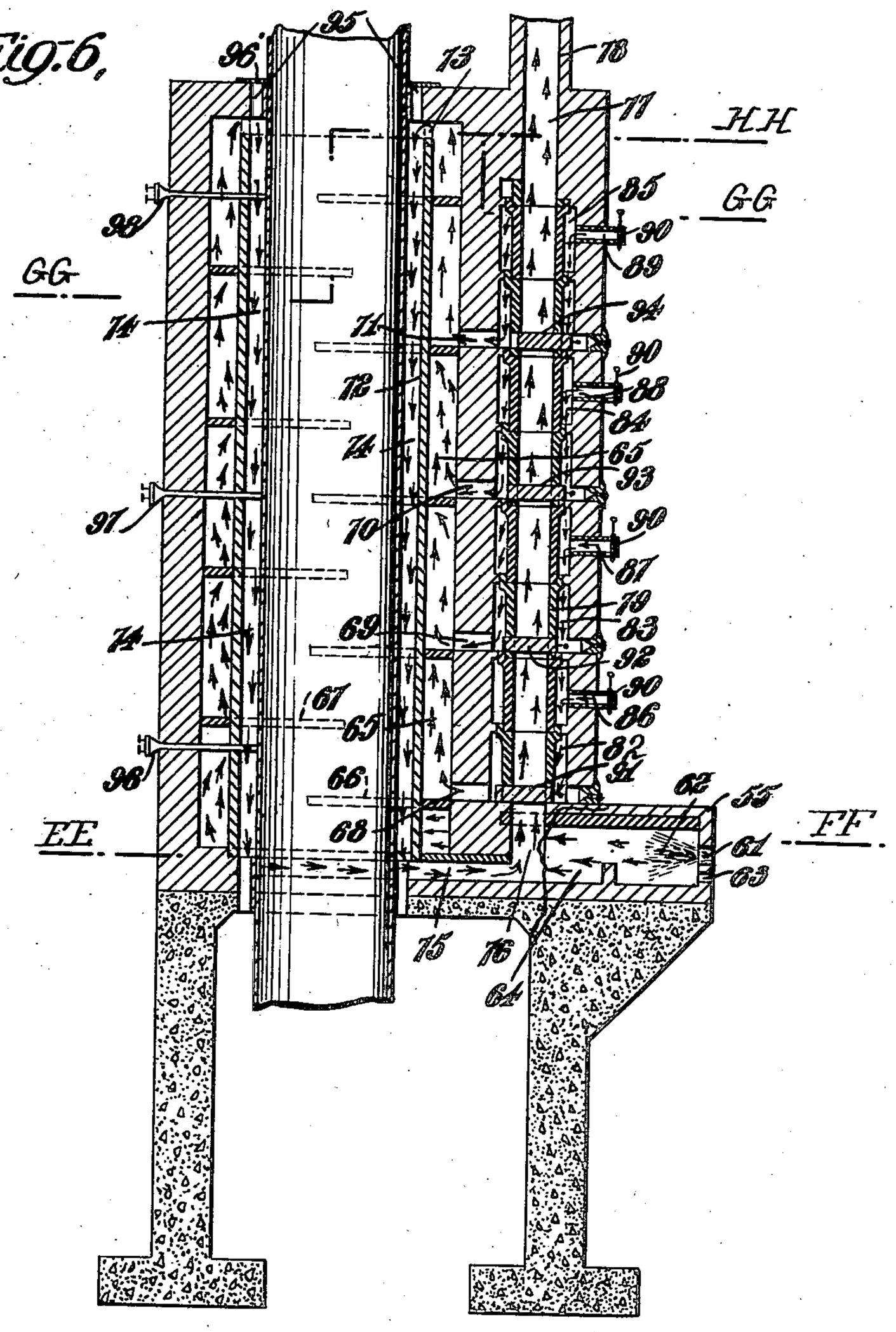
FILED MAR. 15, 1920.

6 SHEETS-SHEET 4

Fig. 6.

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6 SHEETS-SHEET 5

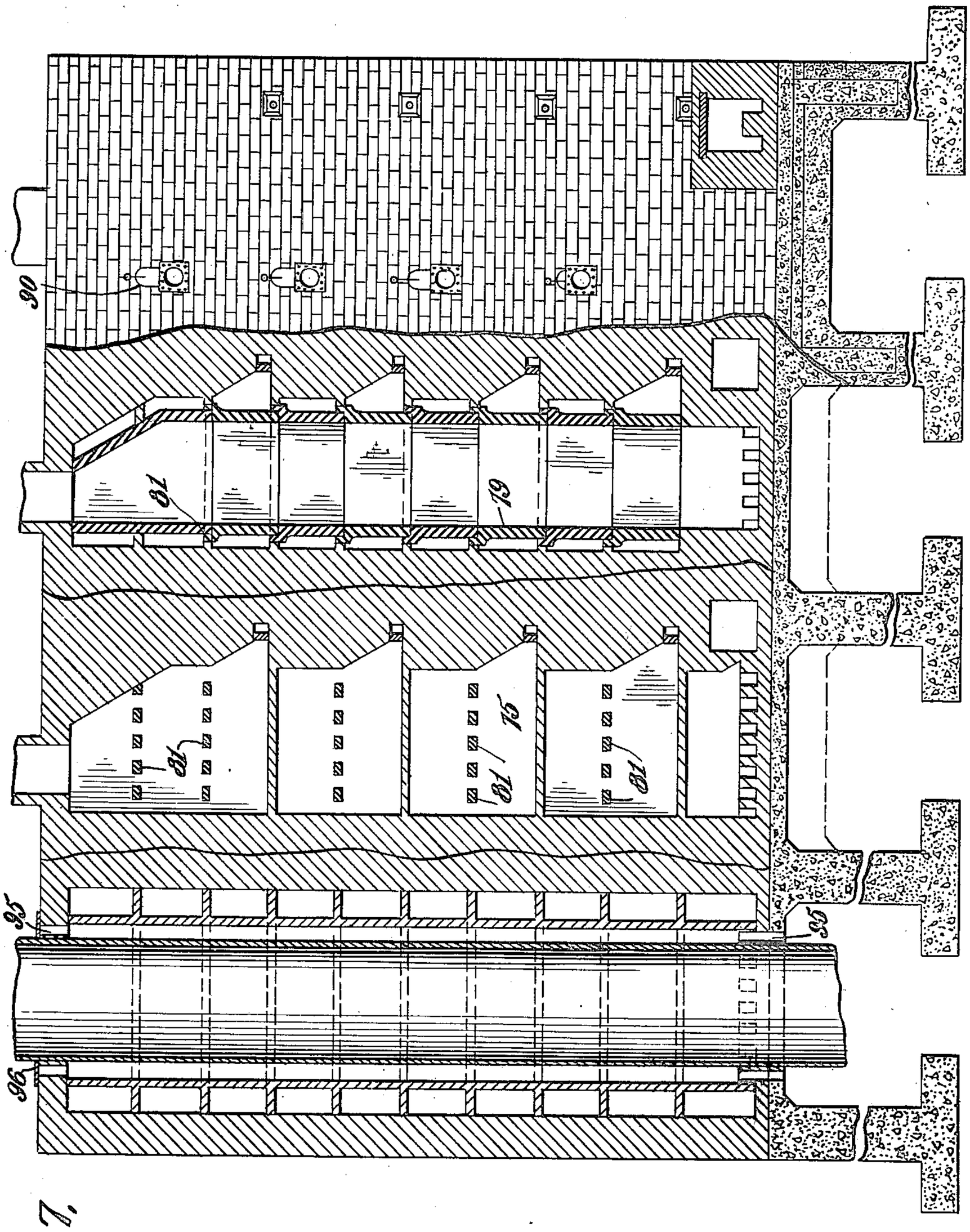


Fig. 7.

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6 SHEETS-SHEET 6

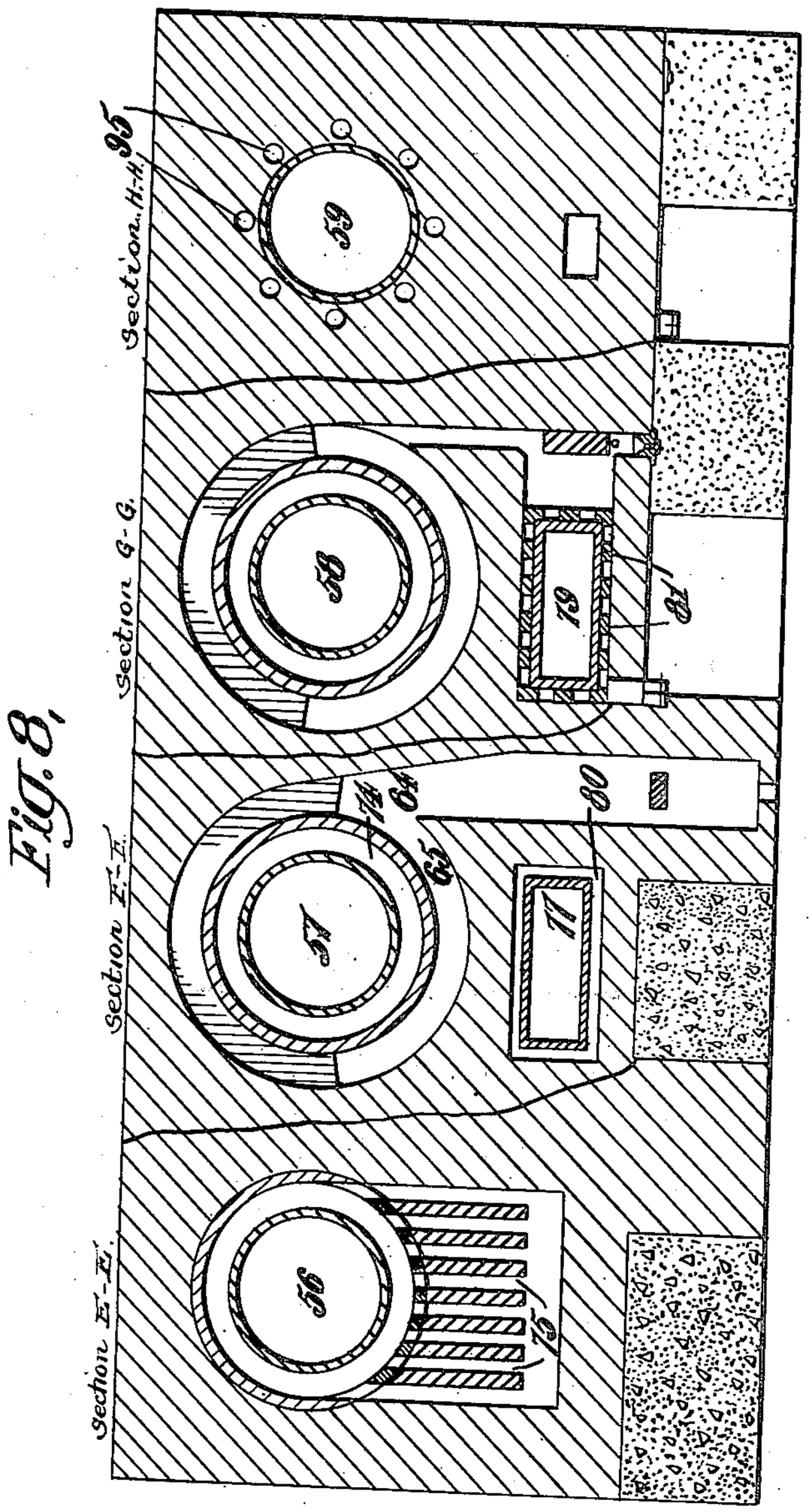


Fig. 8.

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Patented Jan. 2, 1923. 1,440,857

# UNITED STATES PATENT OFFICE.

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## PRODUCER FURNACE.

Application filed March 15, 1920. Serial No. 365,954.

*To all whom it may concern:*

Be it known that I, GEORGE D. WHITE, a citizen of the United States of America, and a resident of Port Arthur, county of Jefferson, and State of Texas, have invented certain new and useful Improvements in Producer Furnaces, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

My invention relates to furnaces, and particularly to such as are adapted to supply heat at high temperatures to chemical retorts or stills.

While the apparatus of my invention is suitable for a wide variety of uses, it is particularly intended for use in the manufacture of anhydrous aluminum chloride or for carrying out other chemical reactions or treatments which require the stills or retorts to be heated to very high temperatures such at 1500° F., 2000° F. and upward.

One object of my invention is to provide a particularly economical and effective furnace in which gas is generated or produced and then conducted to the combustion chamber.

Another object is to provide apparatus of the character above indicated comprising a battery of retorts, a producer furnace, and simple and improved means for regulating and controlling the temperature in various parts of the retorts.

A further object of my invention is to distribute the combustion of the gases in a furnace of the producer type, so as to obtain a desired distribution of heat.

Another object of my invention is to provide a furnace having a primary air inlet, which is restricted so that incomplete combustion occurs, and one or more auxiliary air inlets, provided at suitable points, for carrying forward and finally completing the combustion of the fuel, the location and regulation of the inlets being relied upon for controlling the temperature and heat distribution in the furnace and through the retorts.

In order that my invention may be thoroughly understood I will now proceed to describe the same in the following specification and point out the novel features thereof in appended claims.

Referring to the drawings:

Figure 1 is a sectional elevation of a producer furnace and retorts arranged and constructed in accordance with my invention and constituting an embodiment thereof.

Figure 2 is an enlarged sectional detail corresponding to a part of Figure 1.

Figure 3 is a partially sectional front elevation of the battery of retorts and producer furnace shown in transverse section in Figure 1. The walls and battery of retorts are broken away to a greater or less extent to show the formation and arrangement of the passages.

Figure 4 is a sectional plan view of the same apparatus, showing four different elevations of Figure 1 taken on the lines A—A, B—B, C—C and D—D of Figure 1.

Figure 5 is a sectional plan view showing the producer furnace more in detail and taken on the line 5—5 of Figure 1.

Figure 6 is a sectional elevation of a modified form of my invention.

Figure 7 is a partially sectional front elevation of the furnace and battery of retorts shown in transverse section in Figure 1. The furnace walls and retorts are broken away to a greater or less extent to show the formation and arrangement of the passages.

Figure 8 is a sectional plan view of the same apparatus showing four different elevations of Figure 6 taken on lines E—E F—F, G—G and H—H of Figure 6.

In the drawings, 10 designates a gas producing furnace, and 11 a battery of retorts respectively designated 12—13—14—15. The gas producer furnace has the oil vaporizing burner 16 which discharges into a primary combustion chamber 17, to which a limited amount of air is admitted through a restricted opening 18. The combustion of the hot gases is not complete and the mixture passes out of the producer furnace through a passage 19 into a manifold 20.

From this point the gases are divided and flow through passages 21 to combustion chambers 22 which surround the several retorts 12 to 15. The gas conduits 21 preferably enter the combustion chamber at a tangent, as illustrated, so that the gases will thus be given a swirling motion in their course through the combustion chambers 22. As clearly shown in Figure 1 each of the combustion chambers 22 is formed into a zigzag passage by a plurality of baffle plates 23—24 which extend alternately front and

back of the combustion chamber and materially overlap.

Each of the combustion chambers is thus more or less subdivided and auxiliary air inlets 25—26—27—28 open into the respective subdivisions of the combustion chamber and carry forward and finally complete the combustion of the gases. The hot gases which are completely burned leave the combustion chamber at the top and pass out through a passage 29, flow downward through a heat generating passage 30, and upward through an adjacent heat generating passage 31, finally passing through a passage 32 which is connected to the stack. The arrangement of the heat generating passages 30 and 31 is clearly shown in Figures 3 and 4.

The passages 30 and 31 are formed in the construction illustrated, by a plurality of hollow tiles 33 which are spaced within an opening 34 in such manner that a plurality of air chambers 35—36—37—38 are formed around the heat generating passages 30 and 31. Outside air is admitted to these several chambers near the top through openings 39—40—41—42, each of which is controlled, as clearly shown in Figure 2, by a slide valve 43. Dampers 44—45—46—47 are arranged to control the respective hot air openings 25—26—27—28 and may be opened and closed by any suitable means such as a rod having a hook adapted to engage an eyelet 48 attached to each damper. In order to prevent loss of heat when operating the damper the rod may be introduced through an opening in a plug 49 by removing the stopper 50.

Dampers 51 are provided at the openings in the passages 21 for regulating the relative amounts of gas passing to the several combustion chambers 22.

In operation the burner 16 is started and plenty of air supplied to the primary combustion chamber 17 through the opening 18 until the stills and retorts are heated to a temperature of, say 1600° F., the temperature at different parts of each retort being indicated by pyrometers 52—53—54 as shown in Figure 1.

After this temperature is attained the producer firing is commenced, that is, excess oil is admitted to the burner 16 with enough primary air or steam to volatilize the oil thus producing a hydrocarbon gas, only a small proportion of the gas being subject to combustion in the primary chamber 17. The gases pass through conduit 19 into manifold 20 and are distributed through the openings controlled by dampers 51 into the several passages 21, and thence into the combustion chambers 22.

As the gases enter each combustion chamber 22, as indicated by the arrows in Figure 1, they pass upwardly and are deflected into a zigzag course by the baffle plates 23 and 24. A limited amount of hot air is admitted from the chamber 35 through passage 25 controlled by damper 44 to the lower part of the combustion chamber where it mingles with the gas and produces combustion of a certain percentage of the gases received from the producer and generates heat immediately around the walls of the retort. As the gases pass upwardly through the upper sections of the combustion chamber 22 more air is admitted through the passages 25—26—27—28 until finally combustion is complete.

The burnt gases which pass out of the combustion chamber at the top through passages 29, are at high temperatures and pass downwardly through the conduit 30 and upwardly through the conduit 31. In this way the conduits are highly heated and the heat is taken from the gases and utilized before they pass out through passage 32 to the stack. These conduits 30 and 31, as already explained, constitute heat generating conduits and heat the air which is admitted through regulating valves 43 in the several passages 39—40—41—42 so that the air is delivered hot through the passages 25—26—27—28 and is in particularly good condition to effect complete combustion of the hot gases produced at the nozzle or burner 16.

It is thus apparent that combustion is not established at one point and hot gases carried around the retorts, but combustion is instigated at one point and is carried forward in stages throughout the combustion chambers which are immediately around the walls of the retort.

The amount of heat generated at each part of each retort is capable of control by regulating the air valves 43 and the dampers 44—45—46—47. Thus it is possible to produce a given temperature in one part of the retort and a different temperature in other parts of the retort or the regulation may be adjusted so as to provide a uniform heat distribution around the retort. Not only is it possible to regulate the temperature of each retort but the relative temperatures of the several retorts may be closely and carefully adjusted by regulating the dampers 51 to admit a greater or less quantity of combustible gases to each chamber.

*Examples of temperature regulation.*

Assuming that a uniform temperature of 2000° F. is desired in the combustion chamber 22 from top to bottom, auxiliary firing is resorted to until the temperature of approximately 1600° F. is reached, that is, a suitable mixture is admitted through the nozzle 16 and the admission of air regulated for complete combustion in the combustion chamber 17. When this degree of tempera-

ture is reached producer firing is introduced, the volume of oil admitted through the nozzle being gradually increased and the volume of air or steam being gradually decreased so that only enough is admitted to volatilize the oil into hydrocarbon vapors. The partially burnt gas is then admitted, as already described, to the combustion chamber and the hot auxiliary air is first admitted to the combustion chamber through the passage 25. The amount of gas and oxygen admitted to the main combustion chamber 22 is increased until the desired temperature of 2000° F. is produced at the bottom of the furnace. Then the volume of gas is increased and air is admitted gradually and successively through the passages 25—26—27—28 until the desired temperature of 2000° F. has been obtained uniformly throughout the entire combustion chamber 22 from top to bottom. To increase the temperature the volume of air and gas is increased and vice versa.

If an unequally distributed temperature is desired, as for example, if 2000° F. is desired at the bottom of the retort and 1500° F. at the top, the gas volume is regulated until complete combustion has taken place by the admission of auxiliary air through the lower opening 25, the amount of gas and air being regulated until 2000° F. is indicated by the pyrometer 52. The auxiliary air inlets 26—27—28 are then closed unless the temperature at the top of the furnace is still too high. In this case air is admitted through the opening 28, not for the purposes of combustion, as the combustion is already complete, but in order to mix with the burnt gases and lower their temperatures. By regulating the amount of air and gas admitted the temperature may be held at the desired 1500° F. at the top.

It will be understood that the lower temperature may be maintained at the bottom and the higher at the top if this is the desired arrangement. In this case only a small amount of auxiliary air, if any, is admitted through the lower passages 25—26, the unburnt gases being allowed to pass upwardly and being completely burned by admission of proper quantities of air through the upper openings 27—28.

In any event, all gases are consumed and no unburnt gas passes out into stack. Consequently, the furnace is economical in operation and disagreeable odors are avoided.

In the modified form of my invention shown in Figures 6, 7 and 8 a battery of stills or retorts 56—57—58—59 are provided each of which is equipped with a gas producer furnace 55, although, if desired, a single gas producing furnace with a manifold leading to the several retorts or stills may be used. In the form of apparatus illustrated the gas producer furnace is provided with an oil burner 61 which discharges into a primary combustion chamber 62 to which a limited amount of air is admitted through a restricted opening 63.

Combustion is incomplete in the chamber 62 and the gases pass out of the producer chamber through the gas conduit 64 direct to the combustion chamber 65, the conduits preferably entering the combustion chamber at a tangent as clearly shown in Figure 8. As shown in Figure 6 the combustion chamber 65 is divided into a number of compartments by a plurality of baffles 66—67 which extend alternately front and back of the combustion chamber and materially overlap, forming a zigzag passage for the gases through the combustion chamber. Auxiliary air inlets 68—69—70—71 open into the respective subdivisions of the combustion chamber and furnish the air to carry forward and finally complete the combustion of the gases.

The hot gases which are completely burned leave the combustion chamber at the top, passing out through the wall 72 through the passageway 73 at the top of the furnace and pass downward through the heating chamber 74. If the furnace is properly regulated combustion is completed in the chamber 65 and only the spent gases enter the heating chamber, the retorts thus being protected by the wall 72 from the fire flash of the furnace. Most of the heat of combustion is carried by convection in the current of gases to the heating chamber 74 but a great deal of heat is transferred by radiation.

The gases leave the heating chamber 74 at the bottom and pass out through openings 75 to the passage 76 and are led into the heat generating passage 77. The gases pass upwardly and find an exit through the conduit 78 which is connected to the stack.

In the construction illustrated the heat generating chamber is formed of a number of hollow tiles 79 spaced within an opening 80 and provided with braces 81. Extensions of the baffles 66—67 divide the passage 80 into a number of compartments 82—83—84—85 arranged around the heat generating passage 77. Air is admitted to the several compartments through the openings 86—87—88—89, each of which is controlled by a valve 90. Dampers 91—92—93—94 are arranged to control the respective hot air openings 68—69—70—71 and may be opened and closed by any suitable means such as that illustrated in Figure 2 for operating the dampers 44—45—46—47.

The openings 95 are provided with suitable lids or gates 96′ and serve a twofold purpose: as observation holes permitting the observance of the conditions obtaining in the heating chamber 74 and as means for quickly cooling the still or retort in the

heating chamber upon the completion of a run. The cooling feature especially is of great importance in many industrial operations as it is possible by means of the current of cool air passed through the heating chamber upon opening the gates 96 to cool a retort or still in a comparatively short time. Pyrometers 96—97—98 may serve to indicate the temperature at various parts of the furnace.

That type of my invention illustrated in Figures 6, 7 and 8 is well adapted for such industrial purposes as the distillation of bitumens and carbonaceous substance. For example, it is very advantageous in the distillation of petroleum under super-atmospheric pressures for the purpose of cracking the hydrocarbons. As the fire flash does not come in contact with the still the scaling, burning and coking which usually occurs in spots where stills are exposed to the fire flash is prevented and the life of the still thus prolonged. The downward draft through the heating chamber creates an even flow of hot gases around the periphery of the still. If the combustion in the several compartments be maintained substantially uniform the temperature in the heating passage 74 will vary somewhat from top to bottom being greater at the top and diminishing progressively to the bottom. However the temperature may be maintained substantially uniform throughout the heating chamber 74 by so regulating the auxiliary air inlets that the most intense combustion will take place in the lower compartments of the combustion chamber, the increased heat of radiation from the lower part of the furnace compensating for the decrease in temperature of the convected heat in the lower part of the heating chamber.

One of the chief advantages of my invention is the economy in fuel consumption inasmuch as combustion is carried on so completely that there is a maximum utilization of the fuel used and a minimum in loss of unconsumed combustible gases. Perhaps the primary advantage is the closeness of heat regulation which is possible by the use of my invention.

The number of retorts and the arrangement of passages may be considerably varied within the spirit and scope of my invention, and I intend only such limitations as are indicated in the appended claims.

What I claim is:

1. A furnace comprising a retort, a main combustion chamber around the retort, a producer furnace for supplying hot unburnt gas to the combustion chamber, an air heating conduit connected to receive burnt gas from the combustion chamber, air chambers around said heating conduit, and adjustable means for admitting a greater or less quantity of air from the heating chambers to the combustion chamber.

2. A furnace comprising a retort, a main combustion chamber around the retort, a producer furnace for supplying hot unburnt gas to the combustion chamber, an air heating conduit connected to receive burnt gas from the combustion chamber, air chambers around said heating conduit, a plurality of openings from said air chambers to the combustion chamber, and dampers for regulating the openings to govern the amount of air supplied to different parts of the combustion chamber.

3. A furnace comprising a retort, a main combustion chamber around the retort, a producer furnace for supplying hot unburnt gas to the combustion chamber, an air heating conduit connected to receive burnt gas from the combustion chamber, air chambers around said heating conduit, a plurality of openings from the air heating chambers to the combustion chamber, and means for admitting a predetermined quantity of outside air to the heating chambers.

4. A furnace comprising a plurality of retort chambers, a combustion chamber for heating each retort chamber, a producer furnace for generating hot unburnt gases, a manifold for distributing said gases to the several combustion chambers, means for regulating the distribution of gases through the several branches of the manifold, a plurality of auxiliary air inlets for each of said main combustion chambers, and means for regulating said inlets.

5. A furnace comprising a plurality of retort chambers, a combustion chamber for heating each retort chamber, a producer furnace for generating hot unburnt gases, a manifold for distributing said gases to the several combustion chambers, means for regulating the distribution of gases through the several branches of the manifold, a plurality of auxiliary air inlets for each of said main combustion chambers, and a damper for regulating each of said inlets.

6. A furnace comprising a plurality of retort chambers, a combustion chamber for heating each retort chamber, a producer furnace for generating hot unburnt gases, a manifold for distributing said gases to the several combustion chambers, means for regulating the distribution of gases through the several branches of the manifold, auxiliary air chambers, heating flues arranged to receive hot burnt gases from the main combustion chamber extending through said air chambers and adapted to supply heat thereto, air inlets connecting the air chambers to the main combustion chambers, dampers for controlling said inlets, and cold air inlets to the auxiliary air chambers and control valves therein.

7. A furnace comprising a retort, a heat-

ing chamber surrounding the retort, a main combustion chamber around the heating chamber adapted to supply heat to the heating chamber, a baffle between the heating chamber and main combustion chamber, an initial gas producing combustion chamber adapted to supply a greater or less proportion of unburnt gases to the main combustion chamber, a plurality of passages for admitting air to the main combustion chamber.

8. A furnace comprising a retort, a main combustion chamber around the retort, a baffle between the main combustion chamber and the retort, an initial gas producing combustion chamber adapted to supply a greater or less proportion of unburnt gases to the main combustion chamber, a plurality of passages for admitting air to the main combustion chamber, and means for causing a downward draft of hot gases from the main combustion chamber around the retort.

9. A furnace comprising a retort, a heating chamber having a downward draft surrounding the retort, a main combustion chamber around the heating chamber adapted to supply a current of hot gases to the heating chamber, an initial gas producing combustion chamber adapted to supply a greater or less proportion of unburnt gases to the main combustion chamber, means for varying the intensity of combustion in various parts of the main combustion chamber so that the heat of radiation imparted to the retort therefrom may compensate for the progressive reduction in convected heat supplied to the retort in the downward flow of gases thereby creating an even heat throughout the length of the heating chamber.

10. A furnace comprising a retort, a main combustion chamber adapted to supply heat to said retort, a producer furnace for supplying hot incompletely burnt gas to said combustion chamber, an air heating conduit adapted to receive burnt gas from the combustion chamber, air chambers arranged to be heated by said heating conduit, passages communicating between said heating chambers and the combustion chamber, and dampers in said passages to control the admission of air from said air chambers to the combustion chamber.

11. A furnace comprising a retort, a main combustion chamber adapted to supply heat to said retort, baffles in said chamber dividing same into a plurality of sections, a producer furnace for supplying hot incompletely burnt gas to said combustion chamber, an air heating conduit adapted to receive burnt gas from the combustion chamber, air chambers arranged to be heated by said heating conduit, passages communicating between the several air chambers and the several sections respectively, of the combustion chamber, and means for controlling the passage of air through said openings.

12. A furnace comprising a retort, a main combustion chamber adapted to supply heat to said retort and having a plurality of compartments, a producer furnace for supplying hot incompletely burnt gas to said combustion chamber, an air heating conduit adapted to receive burnt gas from the combustion chamber, air chambers arranged to be heated by said heating conduit, passages communicating between the several air chambers and the several compartments, respectively, of the combustion chamber, and means for controlling the passage of air through said passages.

13. A furnace comprising a retort, a main combustion chamber adapted to supply heat to said retort, a producer furnace for supplying hot incompletely burnt gas to said combustion chamber, air chambers adapted to receive auxiliary air, means for heating said air chambers by means of burnt gas from the combustion chamber, and means for controlling the passage of air from the several air chambers to said main combustion chamber.

14. A furnace comprising a retort, a main combustion chamber consisting of a plurality of sections and adapted to supply heat to said retort, a producer furnace for supplying hot incompletely burnt gas to said combustion chamber, air chambers adapted to receive auxiliary air, means for heating said air chambers by means of burnt gas from the combustion chamber, passages communicating between the several air chambers and the several sections, respectively, of the combustion chamber, and dampers in said passages.

15. A furnace comprising a retort, a main combustion chamber adapted to supply heat to said retort, a producer furnace for supplying hot incompletely burnt gas to said combustion chamber, a plurality of passages through which auxiliary air may be admitted to various points in the combustion chamber, dampers in said passages and means for preheating said auxiliary air by means of burnt gas from the combustion chamber.

16. A furnace comprising a retort, a main combustion chamber formed in sections and being adapted to supply heat to said retort, a producer furnace for supplying hot incompletely burnt gas to the combustion chamber, a plurality of passages communicating with the several sections of the combustion chamber and adapted to conduct auxiliary air to said sections, and dampers in said passages.

In witness whereof, I have hereunto set my hand this 7th day of February, 1920.

GEORGE D. WHITE.